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SEED TREATMENT FOR FIELD LEGUMES

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Seed Treatment for Field Legumes

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THIS bulletin reports results of research** aimed at answering two frequently asked questions:

(1) Will chemical seed treatment of field legumes increase stands and reduce seeding rates, as it does with vegetables, cotton, and some other crops?

(2) Will seed treatment interfere with inoculation of legume seed and formation of nodules on the roots of legumes and thereby reduce their value for soil improvement?

The Oklahoma Station's research on these questions covered a period of two years and included both field and greenhouse tests. The greenhouse tests are believed to be the more reliable, due to varying conditions in the field, hence recommendations made in this bulletin are based chiefly on results of the greenhouse work.

The chemicals tested were Arasan, Ceresan M, Dow 9B, Phygon, and Spergon. Tests† were made on alfalfa, Austrian winter peas, cowpeas (Chinese Red), hairy vetch, mungbeans, and yellow hop clover. This bulletin also includes summaries of tests made in other states with other crops, for the convenience of Oklahoma farmers who do not have access to the research literature.

Results of the Oklahoma research indicate that:

1. Seed treatment increases the percentage of seeds that produce plants, particularly with alfalfa. This means that if seed is treated, less seed can be planted per acre without reducing the stand.

2. Development of nodules is not decreased. In some of the tests it was actually increased.

3. Chemical seed treatment and inoculation with nitrogen-fixing bacteria can both be applied prior to planting without affecting nodulation.

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* At the time the research reported herein was completed, the authors were, respectively: Research Fellow, Department of Botany and Plant Pathology, Oklahoma A. & M. College; and Assistant Plant Pathologist, Oklahoma Agricultural Experiment Station.

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† Respectively: Tetramethylthiuram disulfide; ethylmercuric-p-toluene sulfonilamide; zinc trichlorophenata; 2, 3-dichloro-1, 4-naphthoquineone; and tetrachloro-p-benzoquinone.

TABLE I.—Dosage Rates Recommended for Particular Seed and Chemical.
(Percent by weight of Seed)

Chemical	Alfalfa	Mungbeans	Hairy Vetch	Chinese Red Cowpeas	Yellow Hop Clover
Arasan	.25	1.00	.50	.25	----
Phygon	1.00	.50	.25	.25	----
Spergon	1.00	.50	.25	.25	1.00
Dow 9B	.50	.50	.25	.50	----

Seed to be treated with chemicals can be conveniently shaken with the desired dosage in any container, preferably a large glass jar.

Chemically treated seed to be inoculated can be sprinkled with bacterial inoculum until thoroughly covered. The inoculum should be applied in dry form, since weting will tend to wash off a large amount of the chemical. Dosage rates are given in Table I.

In all cases, it should be remembered that (1) seed should be first tested with chemical before sprinkled with inoculum and (2) inoculum should be applied in dry form.

Experimental Results

EFFECT ON PLANT STANDS

In general, plant stands were significantly* increased by treatment, although no one chemical was best for all legumes. One chemical, Ceresan M, injured all the legume seeds on which it was used the first year, and was omitted from most of the second year's tests. This chemical is valuable for treating other types of seed, but apparently is too volatile for use on legumes.

Alfalfa

Arasan and Phygon produced the greatest increases in plant stands of alfalfa (Table II.) Other chemicals improved the stands, but not as much. In one of the three series of tests made on alfalfa, Dow 9B at the 1% rate caused some damage to seed coats; but no damage was noted in the other two tests. Phygon at the 1% rate caused no hardening of the seed coat, although this sometimes occurs in legumes treated with heavy doses of this chemical.

* For explanation of "significant" as used in this bulletin, see footnote on page 5.

*TABLE II.—Effect on Plant Stand of Variation in Dosage Rates; Greenhouse.**

(Percent)

Chemical	Dosage Rate**	Mungbeans	Cowpeas	Hairy Vetch	Alfalfa
Untreated	----	10	68	50	27
Arasan	.25	34	88	76	50
	.50	38	80	98	51
	1.00	50	80	84	49
Dow 9B	.25	35	80	10	27
	.50	67	88	0	29
	1.00	50	84	0	27
Phygon	.25	45	92	64	48
	.50	68	80	62	48
	1.00	67	84	52	52
Spergon	.25	20	88	64	37
	.50	35	88	56	39
	1.00	30	84	34	41

* Average of three tests for mungbeans and alfalfa.
** Percent by weight of seed treated.

Favorable results from seed treatment of alfalfa have also been obtained in research in Iowa (*4*),** New York (*7*), and Pennsylvania (*5, 9*).

Austrian Winter Peas

Plant stands of Austrian winter peas were generally increased by seed treatment (Table III), but in no case was an increase statistically significant.

Clovers

New York (*7*) and Pennsylvania (*5, 9*) have reported favorable results from seed treatment of clovers; but a Wisconsin test was conflicting.

Oklahoma greenhouse tests of White Dutch and White Sweet Clover were hampered by hardening of seed coats. Field tests were unreliable because of severe flooding of field plots.

Cowpeas

Significantly higher stands of Chinese Red Cowpeas resulted from treatment of seed with Arasan, Dow 9B, Phygon, or Spergon (Tables II and III).

** Italic numerals in parentheses refer to "Literature Cited," page 11.

* All data were analyzed statistically to determine "significance," that is, whether variations were within the range likely to be due to mere chance or were of a kind that might be expected to occur again under similar circumstances. In all tests, both field and greenhouse, the same seed with the same treatment was planted in five different locations. Data shown in this report are averages of these five replications.

Hairy Vetch

Arasan treatment of hairy vetch seed gave the highest plant stands in the greenhouse tests made in 1948 (Table II). Phygon treatment was also significantly superior to no treatment. Seed treated with Dow 9B showed disintegration and charring of the seed coats. Somewhat different rankings were obtained in earlier tests (Table II); but variation between replications* in the field test cast some doubt on the accuracy of the results.

Lespedeza

Favorable results from seed treatment of lespedeza have been reported from Pennsylvania (*5, 9*), and no conflicting evidence has been reported to date from research elsewhere.

Mungbeans

Seed treatment of mungbeans generally produced significant increases in stands in the greenhouse tests (Tables II and III). The germination of untreated mungbean seed was lower than for the other crops tested. In the greenhouse test in 1948 (Table II), Phygon was most effective at all dosages, and produced plants that were strikingly taller and healthier looking than those from seed treated with other chemicals. Phygon treatment at the 1% rate, however, produced some hardening of seed coats.

Peanuts

Tests in several other Southern states have shown good results from seed treatment of peanuts. It is already becoming a general practice.

Soybeans

Numerous tests of seed treatment of soybeans of other experiment stations (*1*) have so far failed to yield any clearcut results.

Yellow Hop Clover

The most consistent increases in plant stands of yellow hop clover were produced by Spergon treatment (Table III), but in all cases treatment was significantly superior to nontreatment in the greenhouse tests.

EFFECT ON NODULATION

There was no indication in any of the tests that chemical treatment of seed interfered with nodule formation, except in the case of Ceresan M. In fact, for most of the legumes tested there

* See footnote on page 5.

TABLE III.—Average Plant Stand of Five Legumes Treated with Various Chemicals.

(Percent)

Chemical*	Austrian Winter Peas		Mungbeans		Cowpeas		Yellow Hop Clover		Hairy Vetch	
	Field	Grnhse.	Field	Grnhse.	Field	Grnhse.	Field	Grnhse.	Field	Grnhse.
Untreated	70	77	48	30	53	57	10	59	74	64
Arasan	76	87	51	69	65	83	20	72	81	76
Ceresan M	58	15	38	7	57	51	12	58	66	53
Dow 9B	75	86	56	71	57	78	25	68	73	82
Phygon	70	82	40	77	52	90	33	79	66	79
Spergon	62	80	44	80	58	87	40	85	53	74

* Seed uniformly treated with all the chemical that would adhere to the seed coat.

*TABLE IV.—Average Nodule Formation of Five Legumes Treated with Various Chemicals; Greenhouse.**

(Percent)

Chemical**	Austrian Winter Peas	Mungbeans	Cowpeas	Yellow Hop Clover	Hairy Vetch
Untreated	73	22	52	54	57
Arasan	86	64	80	69	70
Ceresan M	12	4	49	53	49
Dow 9B	82	66	75	62	79
Phygon	77	74	84	75	76
Spergon	76	78	80	81	71

* Nodule counts were made on plants grown in greenhouse in the test reported in Table I.
** Seed uniformly treated with all the chemical that would adhere to the seed coat.

was considerable evidence that nodulation was improved by treatment with Phygon, Arasan, Spergon or Dow 9B, (Tables IV and V). One difference was noted, however. Nodules on plants grown from treated seed formed on the lateral roots rather than on the tap root, whereas the nodules all formed on the tap roots of plants grown from untreated seed. The same effect has been observed in research elsewhere (*3*).

In testing for nodulation, chemicals were applied first by shaking desired dosage with seed in glass tumblers. Inoculum was sprinkled on the chemically treated seed until thoroughly covered.

Reports of tests elsewhere on the effect of chemical treatment on nodulation are relatively scanty and conflicting. Appleman (*3*) reports satisfactory nodulation on pea and soybean plants grown from inoculated seed treated with Semesan.* Cuprocide,** in his tests, prevented nodulation on soybeans and canning peas.

* and **—See footnote on Page 8.

TABLE V.—Effect of Seed Treatment on Nodulation of Alfalfa and Cowpeas.

Chemical*	Plants with Nodules			
	Alfalfa		Cowpeas	
	Inoculated	Not Inoculated	Inoculated	Not Inoculated
Untreated	37.4	**	53.2	4.5
Arasan	55.4	**	76.0	0.0
Phygon	60.6	0.0	71.2	0.0
Spergon	†	†	63.6	**

* All chemicals applied at 1% rate.
** Less than 1% of plants had nodules.
† Spergon was not used on alfalfa in this test.

Ceresan† decreased nodulation on canning peas but not on soybeans. Kadow, Allison, and Anderson (*8*) found a decrease of nodulation from an average of 75 nodules per plant (not treated) 3 and 4 nodules per plant (treated) †† Duggar (*6*) has demonstrated nodules forming on plants from seed treated with Semesan, copper sulfate, saturated boric acid, bichloride of mercury, and concentrated sulfuric acid. Some of the treatments, however, did decrease nodulation, while others increased it. Buchholz (*3*) reports that small-seeded legumes grown from seed treated with organic mercury dust bore root nodules when planted in the field. Some of the earliest work done by Muller and Stapp (*11*) in Germany demonstrated that if nodule bacteria are in the soil at the time of planting, seed chemicals do not hinder the development of root nodules. Litynski (*10*), in Poland, observed that some treatments reduced nodulation at times and at other times had little or no apparent effect on nodulation.

DOSAGE RATES

Results of tests involving variation of dosage rates are shown in Tables II and V. Dosage rates are calculated in percent of the weight of the seed treated. For example, the 1 percent rate would be one pound of chemical for each 100 pounds of seed.

An excess dosage, above the 1%, was used in one test with Austrian winter peas. The results (Table VI) show that excessive doses tended to reduce the plant stands. Spergon, Phygon, and

* Hydroxymercuric chlorophenol
** Cuprous oxide
† Ethylmercuric phosphate
†† Treated with organic mercury, cuprous oxide, and zinc oxide

Dow 9B were most effective when applied at the 1 percent rate. Arasan was most effective at ½ percent, and Ceresan M at ¼ percent.

In general, seed treatment chemicals should be used at the rate recommended on the package.

Summary

Replicated field and greenhouse experiments on chemical treatment of seed of alfalfa, mungbeans, Chinese Red cowpeas, Austrian winter peas, yellow hop clover, and hairy vetch were conducted from September, 1946, to July, 1948, to investigate the value of Arasan, Phygon, Spergon, Dow 9B, and Ceresan M for seed of these crops. The most outstanding results were as follows:

1. Alfalfa seed treated with Phygon and Arasan at dosages of 1%, ½%, and ¼% by weight of seed gave highly significant germination as compared with non-treated seed. Dow 9B at ½%, and Spergon at all dosages were all superior to non-treatment, but less effective than Phygon or Arasan.

2. Mungbean seed treated with Phygon, Arasan, Dow 9B, and Spergon responded signifantly to treatment, with Phygon at all dosages being most effective and yielding plants that were strikingly taller and healthier looking than other seedlings following seed treatment with the other chemicals.

3. Chinese Red cowpea seed treated with either Arasan, Phygon, Spergon, or Dow 9B gave significantly higher germination figures than did non-treated seed.

TABLE VI.—Effect of Variation in Dosage Rates, Including Excess, on Plant Stand of Austrian Winter Peas; Greenhouse.

(Percent)

Chemical	Dosage Rate			Av. of "normal" rates	Excess
	.25%	.50%	1.00%		
Untreated	83	82	84	83	--
Arasan	83	94	87	88	82
Ceresan M	90	84	74	83	61
Dow 9B	78	83	92	84	74
Phygon	84	85	95	88	87
Spergon	89	91	94	91	81

4. Yellow hop clover seed responded most consistently with Spergon treatment as compared with Arasan, Phygon, Dow 9B, or Ceresan M.

5. Hairy vetch seed yielded highest germination figures when treated with Arasan. Phygon treated seed also was significantly superior to untreated seed in germination.

6. Ceresan M proved to be injurious to all of the legume seed that were treated with this volatile chemical, and it was not in all of the experiments carried on in 1948.

7. Nodulation was not inhibited by chemical treatment of seed of alfalfa, mungbean, yellow hop clover, Chinese Red cowpea, hairy vetch, and Austrian winter peas when chemical treatment was followed by seed inoculation.

8. Nodulation of alfalfa and Chinese Red cowpeas was enhanced when seed of these legumes were treated with Phygon or Arasan and then inoculated. Chemically treated seed yielded more plants with nodules than plants of non-treated seed.

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